A Tangle of Fibers

Scientists examine how different dietary fibers produce their health benefits

By ALINE McKENZIE

Then Daniel said to the guard... "Submit us to this test for ten days. Give us only vegetables to eat and water to drink; then compare our looks with those of the young men who have lived on the food assigned by the king, and be guided in your treatment of us by what you see." The guard listened to what they said and tested them.... At the end of ten days they looked healthier and were better nourished than all the young men who had lived on the food assigned them by the king. So the guard took away the assignment of food and the wine they were to drink, and gave them only the vegetables.

— Daniel 1:11-16

Daniel applied good scientific technique to resist the unkosher diet imposed by the Babylonian king Nebuchadnezzar. Using subjects matched for age, sex and socioeconomic status, he set up a controlled clinical study leading to a simple conclusion: Vegetables are good.

Millennia later, many people looking for good health follow an equally simple philosophy: Fiber is good.

But fiber is not the lifesaving panacea many think, says David Kritchevsky of the Wistar Institute in Philadelphia. Heredity, overall diet, way of life, culture, metabolic differences and other factors confound researchers who try to correlate the risk of heart disease and colon cancer with how much fiber people eat. Even when scientists know what fiber does — for instance, some types clearly lower blood cholesterol — they often don't know exactly how it works.

"People are quick to do studies showing lowered plasma cholesterol if you feed [fiber]," says nutritionist Barbara O. Schneeman of the University of California, Davis. "Very few people are doing studies where they look at what's going on in the gastrointestinal tract. If fiber is going to have a place in the clinical spectrum, then we really do need to better understand the mechanisms in the stomach, the small intestine and the large intestine."

Basically, fiber is any part of a plant that mammals can't digest. But just as the term "vegetable" includes foods as diverse as bell peppers, rhubarbs and bok choy, "fiber" encompasses a variety of substances with widely different properties. Its forms range from the rigid, insoluble cellulose that puts the snap in a stalk of celery to the gummy, soluble fiber of oat bran.

Researchers find that some fibers can act as sponges, absorbing harmful fatty acids and carrying them away from the intestine. Other fibers attract fats through electrical charges. Bacteria ferment still other fibers into acids that change the pH of the gut and block cholesterol synthesis in the liver. These myriad mechanisms belie the television-ad simplicity of "Eat our product — it has fiber."

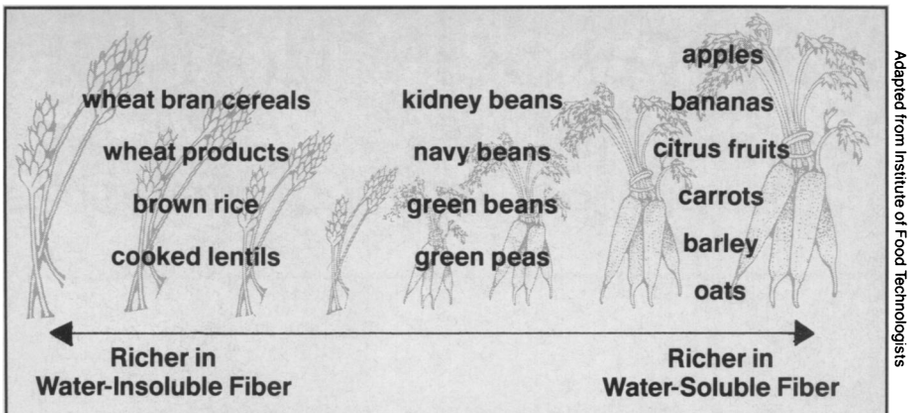
Researchers find some fibers lower blood cholesterol by binding a class of compounds called bile acids. Humans and many other animals break down cholesterol in the liver to form bile acids, which help digest fats in the stomach and small intestine. The small intestine then absorbs the bile acids for reuse.

Pectin, a gel-forming soluble fiber found in fruits and vegetables, packs a one-two punch against bile acids. Carrot pectin sponges up bile acids so the intestine can't reabsorb them, says Peter D. Hoagland of the Agriculture Department's Eastern Regional Research Center in Philadelphia (SN: 6/27/87, p.409). With the bile acids excreted instead of recycled, the liver must break down more cholesterol to make up for the loss. America's latest health darling, oat bran fiber, appears to work in the same way as pectin.

Pectin also works indirectly against the bile acids. Intestinal bacteria ferment soluble fibers — like pectin and oat bran fiber — into short-chain fatty acids, making the intestine's contents more acidic, Hoagland says. Bile acids and other fats don't dissolve well in acid, so they form solid particles that the intestine can't reabsorb. The short-chain fatty acids also appear to travel to the liver, where they block the body's synthesis of cholesterol, says dietician Belinda M. Smith of the University of Kentucky in Lexington.

Jon A. Story, a nutritional physiologist at Purdue University in West Lafayette, Ind., believes bile acid concentration doesn't completely answer how soluble fiber lowers blood cholesterol. He notes, for instance, that green beans reduce blood cholesterol but don't increase the excretion of bile acids. Story plans to measure the relative amounts of different bile acids in the intestines to see which ones most influence cholesterol metabolism.

Some fibers have an electrical attraction for cholesterol that doctors might be able to harness, says Ivan Furda of the James Ford Bell Technical Center of General Mills, Inc., in Minneapolis. Furda studies chitosan, a fiber type found in mushrooms, shellfish shells and some cheeses. Dissolved in the strong acid of the stomach, positively charged molecules of chitosan attract the negatively charged surfaces of micelles – small globules of fat and cholesterol. Later, in the less acidic intestine, the fiber precipitates and entraps the micelles. Purified chitosan is not yet approved for human use, but Furda says preliminary studies in rats, rabbits and chickens show its anti-cholesterol effect to be equal to that of cholestyramine – a positively charged, cholesterol-lowering medication – without the drug's unpleasant side effects.



Foods on the left contain insoluble fiber, which provides "roughage" against constipation and which may reduce the risk of colon cancer. Foods on the right provide soluble fiber, which lowers blood cholesterol. Foods in the middle have both.

Adapted from Institute of Food Technologists

A person worried about heart disease who eats large amounts of oat bran to sweep bile acids out of the small intestine could encounter trouble when the acids reach the colon. There, bacteria convert the so-called primary bile acids into smaller, secondary bile acids – which increase the risk of colon cancer. No one has fully sorted out these teeter-tottering risks of high cholesterol and cancer. "You can't separate one from the other," Story says.

Secondary bile acids do not themselves cause cancer, but they act as co-carcinogens, increasing the chance of cancer when coupled with true carcinogens. Luckily for the health-minded, some fibers – particularly the insoluble fiber in wheat bran – buffer the colon against damage by secondary bile acids.

Wheat bran protects the colon in several ways, says Bandaru S. Reddy of the American Health Foundation in Valhalla, N.Y. By simply increasing the bulk of the stool, it can dilute the concentration of the secondary acids. It also binds them, as pectin binds the primary bile acids, so that they cannot help cancers develop. Moreover, wheat bran reduces the amount of secondary bile acids by making the colon more acidic. The bacteria that convert primary bile acids to secondary ones don't grow well in an acidic environment.

Wheat bran reduces the small intestine's ability to absorb dietary calcium and to pass it along to the bloodstream. Extra calcium in the intestines reduces the rate of colon cancer in rats, and European studies show that people who eat calcium-rich dairy products have lower rates of colon cancer than those who don't, Story says.

To see how wheat bran, calcium and bile acids interact in the colon, David S. Alberts and his colleagues at the Arizona Cancer Center of the University of Arizona in Tucson last year began a double-blind study involving 100 people with polyps who have a high risk of developing colon cancer. Working in collaboration with Story, they hope to finish their study by next spring.

In a pilot study preceding the large trial, the researchers provided a daily serving of wheat bran cereal to 17 people previously treated for colon cancer. Early results from the pilot study look promising: After two months, the cellular turnover rate slowed by 20 percent in nine of the 17 volunteers on the wheat bran regimen. The people who had the highest turnover at the beginning of the study showed the most improvement, says project director Mary K. Buller.

In colon cancer survivors, cells lining the colon slough off at twice the normal rate, increasing the chance that an error during cell division may turn the overactive cell cancerous. This rapid turnover probably contributes to the high recurrence rate of colon cancer. Bile acids probably make the colon more vulnerable to cancer because they irritate the lining and stimulate an even faster turnover, Buller says.

Researchers are just beginning to figure out which components in different fibers produce the various effects observed. Carrot and grapefruit pectins, for instance, both lower blood cholesterol, but they have different chemical structures and may work through different mechanisms (SN: 7/25/87, p.63). "The real problem for the next few years is to try to correlate structure and function so that we can show what particular parts of the fiber molecules are doing the job we're looking for," Kritchevsky says.

Some proteins produced by cancer-promoting genes need mevalonate, a metabolic precursor to cholesterol, to anchor themselves in the cell membrane. Biochemist Jasper Rine and his co-workers at the Lawrence Berkeley Laboratory and the University of California, Berkeley, recently found that two cholesterol-lowering drugs block this step (SN: 7/29/89, p.70). The drugs' ability to block the action of genes that promote pancreatic and colon cancer has nothing to do with their cholesterol-lowering action, Rine says.

In 1985, nutritionist Charles E. Elson and his colleagues at the University of Wisconsin-Madison isolated oily substances from the fiber in barley and citrus peel that interfere with cholesterol synthesis. One oil, d-limonene, shrinks mammary tumors in rats. D-limonene blocks the deadly action of three different carcinogens, and so probably acts on the tumor itself, Elson says, but the researchers have yet to uncover the connection between cholesterol synthesis and cancer. "I draw a lot of correlations but no mechanisms," he says.

Because soluble and insoluble fiber have such intertwined and poorly understood effects on heart disease and colon cancer, people shouldn't go overboard in eating too much of one type of fiber, Story says. For example, a very strict diet high in soluble fiber can often lower blood cholesterol and can help someone who stands a high risk of heart disease, but it wouldn't necessarily benefit people who are at low risk – and it might increase their chances of colon cancer. Eating too much fiber can also interfere with the body's absorption of minerals and cause calcium or zinc deficiencies, especially in older people and children, Kritchevsky says.

The National Research Council recommends that adults eat five or more daily servings of fruits and vegetables and six or more servings of breads, cereals and legumes – a diet that provides a good mixture of soluble and insoluble fiber. "Don't stick to one type of fiber," Bandaru advises. "The combination of fibers is very important. If you eat wheat bran and oat bran, you are satisfying the cholesterol-lowering people *and* the cancer-lowering people." □